CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins

For

The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta

April 2006 Public Review Draft

Appendix D

Cost Calculations

D1. Introduction

Appendix D contains tables showing the calculations used to determine the potential cost of implementing the proposed Basin Plan amendment, including implementation of management practices, monitoring and planning alternatives within the Delta Watershed.

Table D-1. Total Estimated Costs For the Implementing the Proposed Basin Plan Amendment

	Low Cost Estimate ($/yr)[1]	High Cost Estimate ($/yr)
Dormant Season Practices (See Table D-2)	-16,125	175,225
Irrigation Season Practices (See Table D-3)	5,895,336	12,483,858
Monitoring and Planning Costs (See Tables D-4 and D-5)	500,092	1,773,000
Total	**6,379,303**	**14,432,083**

Table D-2 Estimated Cost For Dormant Season Management Practices (Based on cost estimates from Beaulaurier et al., 2005[2])

Crop	Acres Treated with Chlorpyrifos During Dormant Season[3]	Low Cost $ /acre-yr	high cost $/acre-yr	Low Cost $/yr	High Cost $/yr
Almonds	114	-15	163	-1,710	18,582
Cherries	17	-15	163	-255	2,771
Apples	944	-15	163	-14,160	153,872
total				**-16,125**	**175,225**

[1] Negative values indicate a cost savings.
[2] With cost corrections as documented in Landau, 2006.
[3] New diazinon label requirements (MANA, 2004) are expected to adequately control dormant season diazinon discharges. Therefore, costs of implementing management practices for diazinon use during the dormant season are not included in these calculations.

Table D-3 Cost Estimates for Implementation of Irrigation Season Management Practices

Crop	Crop Type	Acres Treated with Diazinon or Chlorpyrifos during Irrigation Season	% of acres applicable	low cost $/acre-yr (see Tables D-7 and D-8)	high cost $/acre-yr (see Tables D-7 and D-8)	low cost $/yr	high cost $/yr
Pears	orchard	3,296	60	60	196	118,656	387,610
Cherries	orchard	1,835	60	60	196	66,060	215,796
Walnuts	orchard	26,933	60	60	196	969,588	3,167,321
Plums	orchard	956	60	60	196	34,416	112,426
Apples	orchard	3,338	60	60	196	120,168	392,549
Almonds	orchard	9,793	60	60	196	352,548	1,151,657
Tomatoes	field and row	4,876	100	60	100	292,560	487,600
Melons	field and row	807	100	60	100	48,420	80,700
Alfalfa	field and row	56,842	100	60	100	3,410,520	5,684,200
Corn	field and row	2,829	100	60	100	169,740	282,900
Asparagus	field and row	1,573	100	60	100	94,380	157,300
Cotton	field and row	992	100	60	100	59,520	99,200
Grapes	field and row	2,241	100	60	100	134,460	224,100
Sunflowers	field and row	405	100	60	100	24,300	40,500
Total						**5,895,336**	**12,483,858**

Table D-4 Estimated Monitoring and Planning Costs for Watershed Group Compliance

Water Quality Monitoring Cost	
Number of Sites	48
Number of Environmental Samples (See Table D-5)	962
Total # of samples including 30% QA/QC Samples	1,251
Cost per Sample	$ 200
Total Analytical Costs	$ 250,120
Number of Toxicity Samples	20
Total Cost of Toxicity Analyses (assumes 1,000 per sample average cost)	$ 20,000
Number of Pyrethroid Samples	20
Total Cost of Pryrethroid Samples	$ 4,000
Number of Person-days for sample collection. Assumes 2 person crew can cover 6 sites.	321
Sample collection preparation as a percent of Person-days for sampling.	25%
Total Person-days for Sample Collection & Preparation	401
Cost per Person-day	$ 150
Sampling personnel cost	$ 60,150
Travel Costs (assumes each person day involves 300 miles of driving at 0.35 per mile)	$ 29,822
Equipment/Supplies	$ 20,000
Monitoring Plan & Quality Assurance Plan (Assumes 1 person month @ 10,000 per person month)	$ 10,000
Monitoring Program Coordination (Assumes 1 year at 50% time at 10,000 per person month)	$ 60,000
Annual Monitoring Report	$ 30,000
Total Monitoring Cost	**$ 380,092**
Planning and Evaluation Cost	
Implementation Plan (Assumes 3 person months @ 10,000 per person month)	$ 30,000
Implementation Plan Coordination, Delta Watershed - Wide (assumes 12 months at 50% time at 10,000 per person month)	$ 60,000
Annual Implementation Report, Including Practices Effectiveness Evaluation (Assumes 3 months at 10,000 per person month)	$ 30,000
Total Planning and Evaluation Cost	**$ 120,000**
Total annual cost for basin-wide monitoring, planning, and evaluation	
Total Cost	**$ 500,092**
Total Number of Growers	900
Cost per Grower	**$ 556**

Table D-5 Estimated Monitoring and Planning Costs for Individual Compliance

Water Quality Monitoring Cost	
Number of Tailwater Samples Collected per site	2
% QA/QC Samples	30%
Total # of samples	3
Cost per Sample	$ 200
Total analytical costs per site	$ 600
Cost for sampling collection and flow estimate (including preparation and shipping). Assumes 2 hrs per sample @ 40/hr.	$ 160
Travel Costs (50 mi per trip/ 0.35 per mile.)	$ 35
Bottles and Supplies (5/sample)	$ 15
Monitoring and Quality Assurance Plan. Assumes 8 hours time @ 40/hr	$ 320
Annual Monitoring Report (assume 8 hrs time @ 40/hr)	$ 320
Total Monitoring Cost per Site	**$ 1,650**
Planning and Evaluation Cost	
Implementation Plan (Assumes 4 hours @ 40 per person hour)	$ 160
Annual Implementation Plan Report Including Effectiveness Evaluation (Assumes 4 hours @ 40 per person hour)	$ 160
Total planning cost	**$ 320**
Total annual cost for basin-wide monitoring, planning, and evaluation	
Cost per Grower (assumes 1 monitoring site per grower)	**$ 1,970**
Total Number of Growers	900
Basin-wide Cost	**$ 1,773,000**

Table D-6. Estimated Number of Samples For Watershed-Based Compliance Monitoring

	Sites	Storms	OP Samples per Storm	Storm OP Samples/Yr	Irrigation OP Samples/ Station	Irrigation OP Samples/Yr	Toxicity Samples/Yr	Pyrethorid Samples/Yr
Delta Rivers								
Cache Slough nr outlet	1	5	6	30	12	12		
Sac R. at Freeport	1	5	6	30	12	12		
Sac R at Rio Vista	1	5	7	35	12	12	5	5
Sac R nr Outlet	1	0	0	0	0	0		
SJR at Stockton	1	5	3	15	12	12		
SJR near Antioch	1	0	0	0	0	0		
Mokelumne R d/s Geogiana Slough	1	5	3	15	12	12		
Old R nr Tracy	1	5	3	15	12	12		
Old R nr Bacon Island	1	5	3	15	12	12		
Middle R nr Union Island	1	5	3	15	12	12		
Middle R nr Middle R. CA	1	5	3	15	12	12		
Major Delta Tributaries								
Sacramento	1	*	*	*	*	*		
Colusa Basin Drain	1	*	*	*	12	12		
San Joaquin	1	*	*	*	*	*		
Yolo bypass	1	5	6	30	12	12		
Cosumnes R	1	5	3	15	12	12		
Mokelumne R	1	5	3	15	12	12		
Calaveras R	1	5	3	15	12	12		
Other Delta Tributaries and Waterways (see Appendix E for a description of the Delta Subareas)								
Central Delta								
Delta Waterways	2	5	1	10	12	24		
Island Drains	1	5	1	5	6	6		
Eastern Delta and Tributary Area								
Back Sloughs	2	5	1	10	12	24	5	5
Delta Waterways	2	5	1	10	12	24		

	Sites	Storms	OP Samples per Storm	Storm OP Samples/Yr	Irrigation OP Samples/ Station	Irrigation OP Samples/Yr	Toxicity Samples/Yr	Pyrethorid Samples/Yr
Small Upland Drainages	2	5	3	30	12	24		
Island Drains	1	5	1	5	6	6		
Northern Delta								
Back Sloughs	2	5	1	10	12	24		
Delta Waterways	2	5	1	10	12	24		
Island Drains	1	5	1	5	6	6		
Northwest Delta and Tributary Area								
Back Sloughs	2	5	1	10	12	24	5	5
Delta Waterways	2	5	1	10	12	24		
Small Upland Drainages	2	5	3	30	12	24		
Island Drains	1	5	1	5	6	6		
Southern Delta and Tributary Area								
Back Sloughs	2	5	1	10	12	24	5	5
Delta Waterways	2	5	1	10	12	24		
Island Drains	1	5	1	5	6	6		
Western Delta and Tributary Area								
Delta Waterways	0	0	0	0	12	0		
Small Upland Drainages	2	5	3	30	12	24		
Island Drains	1	5	1	5	6	6		
Totals	48			470		492	20	20

D2. Citations

Beaulaurier, D., G. Davis, J. Karkoski, M. McCarthy, D. McClure, M. Menconi. 2005. Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Diazinon and Chlorpyrifos Runoff into the Lower San Joaquin River.

Landau, K. 2006. Corrections To Basin Plan Amendment for the Control of Diazinon and Chlorpyrifos Runoff into the San Joaquin River. Memo from Ken Landau (Acting Executive Ofiicer, California Regional Water Quality Control Board, Central Valley Region) to Celeste Cantu (Executive Director, State Water Resources Control Board) dated January 26, 2006.

MANA. 2004. Supplemental Label, Diazinon 50W Insecticide, EPA Registration Number 66222-10. Makhteshim Agan of North America (MANA). New York, NY.

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Appendix E

Detailed Background Information for Seven Geographic Subareas Within the Delta Watershed

Introduction

This appendix provides additional background information to supplement that provided in Chapter 2 of the main report. Since the Delta watershed is large and varied in terms of topography, hydrology, and water sources, seven subareas were defined within the Delta watershed boundary based on dominant hydrologic characteristics in order to facilitate detailed evaluations of diazinon and chlorpyrifos use, transport, and presence in surface waters. The seven subareas are the Colusa Basin, Northwestern Delta and Tributary Area, Northern Delta, Eastern Delta and Tributary Area, Southern Delta and Tributary Area, Central Delta, and Western Delta and Tributary Area, as shown in Figure E-1. Pesticide use, geographic extent, general hydrology, and diazinon and chlorpyrifos surface water concentrations are discussed for each subarea.

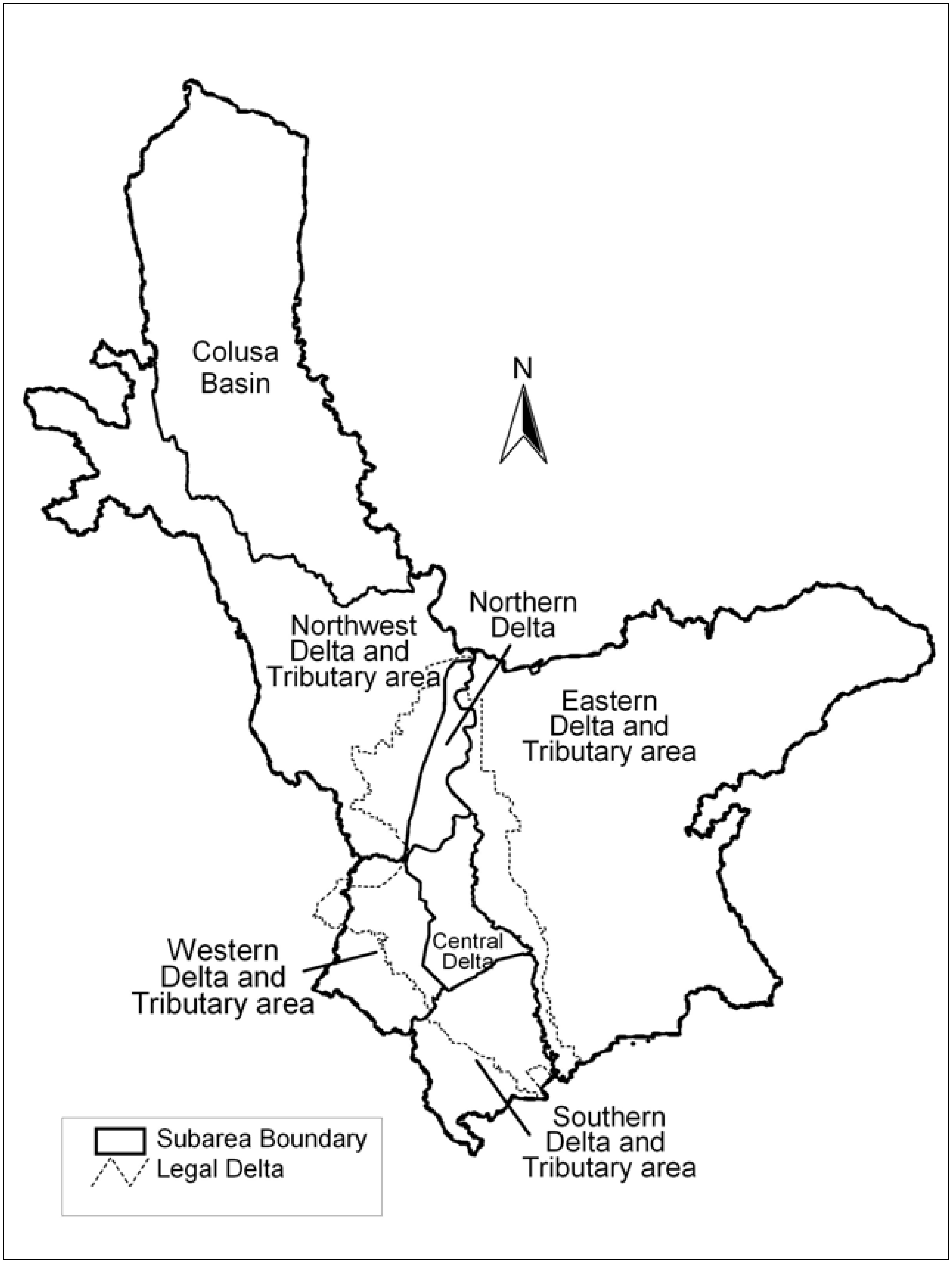

Figure E-1 Seven Delta Subareas

Diazinon and Chlorpyrifos Use in the Seven Delta Subareas

Table E-1 shows the annual average agricultural use of diazinon and chlorpyrifos in the seven Delta subareas, using pesticide use data from 1999-2003 (DPR, 2004). While there is significant reported agricultural usage in all the subareas, the annual average use varies significantly as do the relative quantities of diazinon and chlorpyrifos used in each subarea. In the Northern and Western Delta, more diazinon is applied than chlorpyrifos. In the other subareas, more chlorpyrifos is used than diazinon.

Tables E-2 and E-3 summarize the highest reported agricultural diazinon and chlorpyrifos uses by the subareas in which they occur. These tables show that the different Delta subareas have diverse uses of diazinon and chlorpyrifos. The major diazinon applications by crop and subarea (averaging approximately 1,000 lbs/year or greater) are: almonds in the Colusa Basin and Eastern Delta; tomatoes in the Colusa Basin, Northwest and Southern Delta and Tributary Areas; plums (dried and fresh) in the Colusa Basin and Northwest Delta and Tributary Area; cherries in the Eastern Delta, pears in the Northern Delta and apples in the Eastern Delta and Tributary Area. The major chlorpyrifos applications by crop and subarea (averaging approximately 1000 lbs/year or greater) are walnuts in all subareas except the Central Delta and the Western Delta and Tributary Area (but with the greatest amount used by far in the Eastern Delta and Tributary Area); alfalfa in all subareas except the Western Delta; almonds in the Colusa Basin, Eastern and Northwest Delta and Tributary Areas; corn and apples in the Eastern Delta and Tributary Area, asparagus in the Central Delta, cotton in the Colusa Basin; and grapes in the Eastern Delta and Tributary Area.

Table E-1 Diazinon and Chlorpyrifos Agricultural Use by Subarea

Delta Subarea	Size of Subarea (Acres)	Annual Average Use (lbs, 1999-2003)	
		Diazinon	Chlorpyrifos
Central Delta	141,800	355	3,501
Colusa Basin	1,103,266	15,814	21,548
Eastern Delta and Tributary Area	1,751,972	17,824	49,391
Northern Delta	92,995	4,396	3,690
Northwest Delta and Tributary Area	910,202	5,628	23,322
Southern Delta and Tributary Area	248,578	2,036	12,141
Western Delta and Tributary Area	202,072	1,599	508
TOTAL	4,450,885	47,652	114,101

Table E-2 Major Agricultural Diazinon Uses by Crop and Subarea (1999-2003 Annual Average Pounds Applied)

Crop	Delta Watershed Subarea						
	Central	Colusa Basin	Eastern	Northern	Northwest	Southern	Western
Almonds	0	6,416	7,576	0	258	123	0
Tomatoes	141	2,882	624	178	1,922	1,316	1
Plums	0	4,774	14	6	1,790	0	26
Cherries	0	2	5,633	110	24	2	168
Pears	205	2	427	3,677	2	0	3
Apples	4	1	1,354	381	32	0	906

Table E-3 Major Agricultural Chlorpyrifos Uses by Crop and Subarea (1999-2003 Annual Average Pounds Applied)

Crop	Delta Watershed Subarea						
	Central	Colusa Basin	Eastern	Northern	Northwest	Southern	Western
Walnuts	15	6,137	22,617	76	10,422	1,427	70
Alfalfa	1,555	4,749	10,612	1,357	9,003	8,381	97
Almonds	0	7,040	6,524	0	753	301	2
Corn	26	298	3,792	0	502	254	127
Sugarbeets*	87	401	1,238	554	894	804	2
Apples**	4	421	*2,367*	460	37	106	204
Asparagus	1,814	3	622	14	3	767	0
Cotton	0	1,656	0	0	274	84	0
Grapes	0	8	989	140	0	0	6

* Sugarbeets are no longer grown in significant quantities in or around the Delta.
** Use of chlorpyrifos on apples has been canceled

The Colusa Basin

The Colusa Basin subarea includes all the area that drains into the Colusa Basin Drain, extending from near Orland on the north southward past the cities of Willows, Colusa, and Williams to just north of Woodland. The surface water in the Colusa Basin consists of local runoff from irrigation and rainfall within the Colusa Basin. The Colusa Basin subarea is bound on the north and west by the boundaries of the Colusa Basin Drain's watershed, on the east by the western levee of the Sacramento River, and on the south by the Northwest Delta and Tributary Subarea. This basin is addressed in both this Basin Plan Amendment and the Sacramento River Diazinon TMDL (Karkoski et al., 2003). The runoff in the Colusa Basin Drain can either drain directly into the Sacramento River upstream of the Delta near Knights Landing, or it can be totally or partially diverted south into the Delta via the Knights Landing Ridge Cut and the Yolo Bypass for water supply or for flood control when the water level in the Sacramento River is high following winter storms. Figure E2 shows the Colusa Basin and the monitoring site from which pesticide concentration data were obtained for this report.

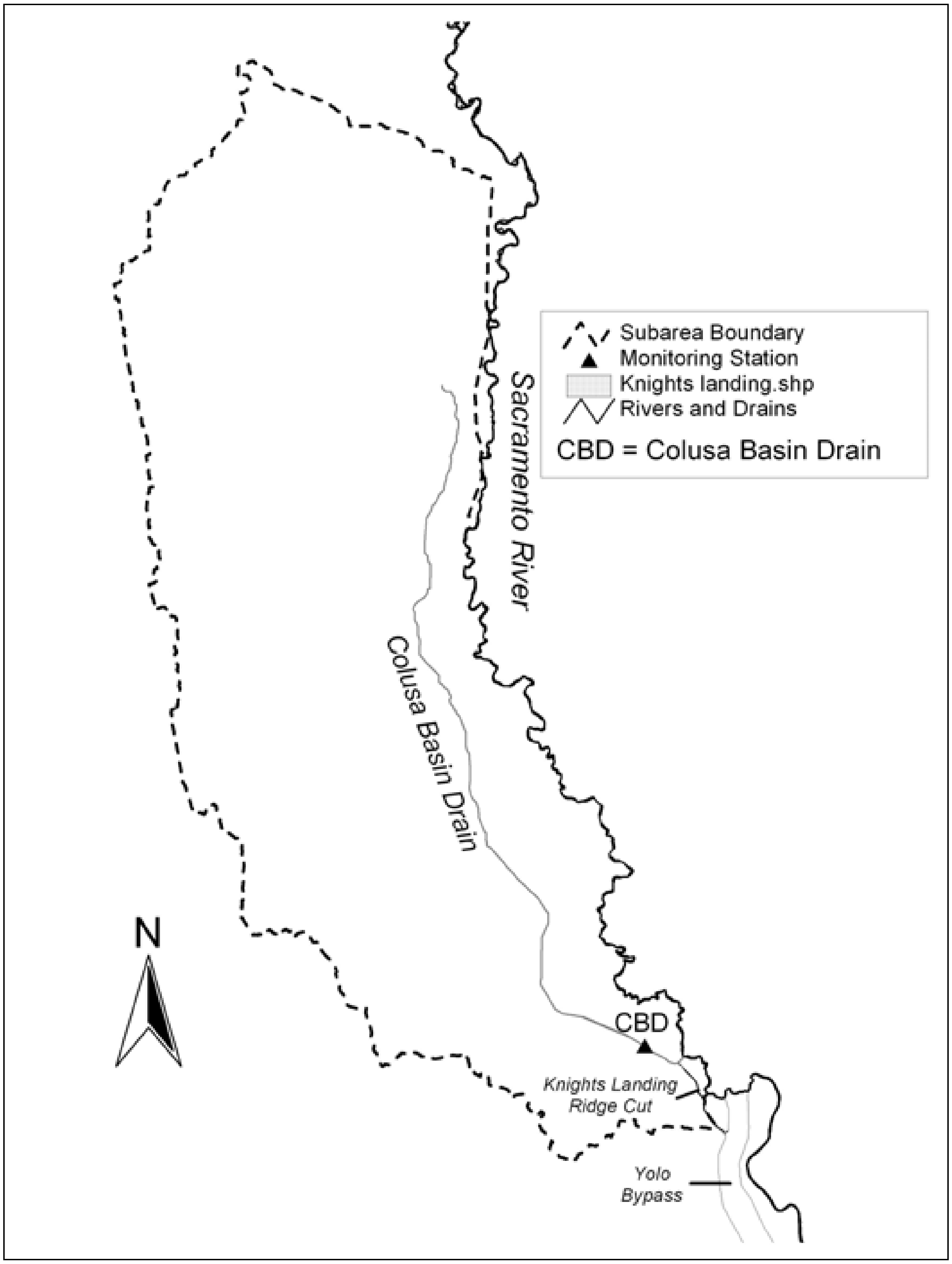

Figure E2. The Colusa Basin

Diazinon and Chlorpyrifos Use in the Colusa Basin

Agricultural diazinon use in the Colusa Basin averages approximately 16,000 pounds per year, based on use data from 1999-2003. The main crops on which diazinon is used in this subarea are almonds, plums and prunes, and tomatoes. Agricultural chlorpyrifos use in the Colusa Basin averages approximately 22,000 pounds per year, based on use data from 1999-2003, with the main uses being almonds, walnuts and alfalfa and cotton.

Diazinon and Chlorpyrifos in the Colusa Basin Drain

Almost all of the Colusa Basin drains to the Colusa Basin Drain. The Colusa Basin Drain at Knights Landing, just upstream of where it drains into the Knights Landing Ridge Cut, and/or the Sacramento River is a good integrator site for determining the loads and concentrations that are discharged from this basin into the Yolo Bypass and/or the Sacramento River. Table 2.17 shows diazinon and chlorpyrifos concentrations measured in the Colusa Basin Drain at Knights Landing. The available data indicate that the concentrations of diazinon and chlorpyrifos both occasionally exceed the proposed criteria for these pesticides, but diazinon tends to be present at levels of concern much more frequently. This site had the highest chlorpyrifos concentration in the entire data set for the Delta watershed (700 ng/L on 6/22/2001).

Table E4. Diazinon and Chlorpyrifos Concentrations for the Colusa Basin Drain Near Knights Landing

Diazinon					
# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of samples > 160 ng/L
170	20	120	420	13	8%
Chlorpyrifos					
# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of samples > 25 ng/L
87	0	0	700	1	1%
Combined Criteria-Normalized Diazinon and Chlorpyrifos					
# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of samples S > 1
74	0.1	0.6	28.0	4	5%

[1] S = The sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Northwest Delta and Tributary Subarea

The Northwest Delta and Tributary subarea includes the northwest corner of the legal Delta as well as the lands and waterways to the northwest of the legal Delta that drain into the Delta. The surface water within the Northwestern Delta and Tributary subarea is mostly water from upstream reservoir releases and runoff from irrigation and rainfall, but also consists of tidal flows from the Northern Delta. At high flows, the surface water within the Northwestern Delta and Tributary subarea also contains Sacramento River water that flows into the Yolo Bypass via Fremont and Sacramento Weirs, and contains Colusa Basin Drain water that flows into the Yolo Bypass via the Knights Landing Ridge Cut. Nearly all of the Northwest Delta and Tributary subarea drains into the Sacramento River in the Northern Delta via Cache Slough. The Northwest Delta and Tributary subarea is bound on the north by the Colusa Basin subarea, on the east by the western levees along the Sacramento River and the Sacramento River Deepwater Ship Channel, on the south by the Western Delta and Tributary subarea, and on the west by the upstream extents of the Putah and Cache Creek watersheds downstream of Clear Lake and Lake Berryessa, respectively. The Northwest Delta and Tributary subarea includes the watersheds of lower Putah and Cache creeks and the other tributaries of the Yolo Bypass, as well as the areas to the west of the Yolo Bypass that drain southward to Sacramento River upstream of the cities of Rio Vista, and encompasses Winters, Woodland, West Sacramento, Rio Vista, and Vacaville.

The Yolo Bypass is a levied floodplain that carries floodwaters from the Sacramento River and several other Central Valley waterways into the Delta. The Yolo Bypass begins at the Fremont Weir, just across the Sacramento River from the terminus of the Sutter Bypass. When the flows in the Sacramento River are high from storm runoff, significant portions of Sacramento River flows enter the Yolo Bypass via the Fremont Weir and the Sacramento Weir. The Yolo Bypass is bound by levees on its western side and is bound on its eastern side by the Tule Drain (which becomes the Toe Drain in its southern reach) and the East Bypass levee. When not flooded, the land in the Yolo Bypass is used for growing agricultural crops such as rice, tomatoes and corn, and for managed wetland habitat. The Knights Landing Ridge Cut conveys water from the Colusa Basin into the Yolo Bypass just south of the Fremont Weir. Cache Creek flows southeast from Clear Lake into the Yolo Bypass near the city of Woodland. Willow Slough and the Willow Slough Bypass flow into the Yolo Bypass just north of the city of Davis. Putah Creek flows east from Lake Berryessa into the Putah Creek Sinks, which is in the Yolo Bypass just south of the city of Davis. The Yolo Bypass, the Sacramento Deepwater Ship Channel, Lindsey Slough, Prospect Slough, Miners Slough, and Steamboat Slough, all flow into Cache Slough before it empties into the Sacramento River just upstream of the city of Rio Vista. These tributaries of Cache Slough receive agricultural drainage from Yolo and Solano county farmland. Putah Creek receives treated wastewater discharges from the cities of Davis and Winters. Therefore, the water in the Northwest Delta and Tributary subarea is a mix of local runoff, including both agricultural and urban runoff; seasonal flows from the Colusa Basin; flows from the Sacramento Valley during high flows, when the Sacramento River flows into the Yolo Bypass; and tidal mixing from the Northern Delta. Figure E3 shows the Northwest Delta and Tributary subarea, and the monitoring sites from which pesticide concentration data were obtained for this report.

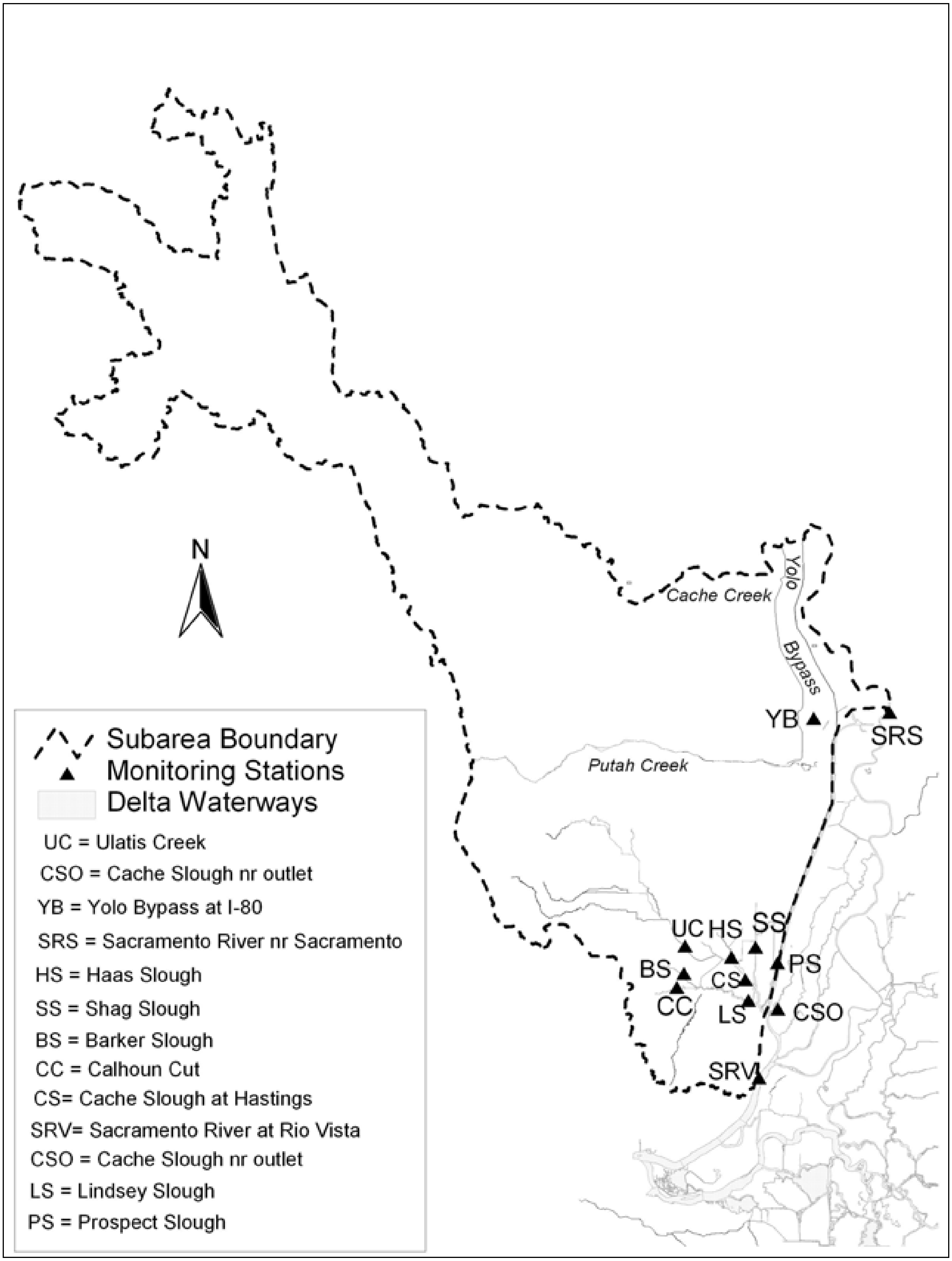

Figure E3. The Northwest Delta and Tributary Area

Diazinon and Chlorpyrifos Use in the Northwest Delta and Tributary Area

Agricultural diazinon use in the Northwest Delta and Tributary subarea averages approximately 5,600 pounds per year, based on use data from 1999-2003, with the main uses being on tomatoes and plums (dried and fresh). Agricultural chlorpyrifos use in the Northwest Delta and Tributary Area averages approximately 23,000 pounds per year, based on use data from 1999-2003, with the main uses being on walnuts and alfalfa.

Diazinon and Chlorpyrifos in the Northwest Delta and Tributary Area

Tables E5, E6, and E7 summarize diazinon and chlorpyrifos surface water concentration data for this subarea. Since nearly all of the Northwest Delta and Tributary area drains to Cache Slough, Cache Slough near its outlet makes a good integrator site for describing the contribution to the Delta pesticide loads from the Northwest Delta and Tributary subarea. Unfortunately, the available data for the Yolo Bypass and Cache Slough are very limited relative to the potential significance of the pesticide loading to the Delta from this tributary, particularly since the Yolo Bypass is the third largest source of flow into the Delta. Although there are limited data available for Cache Slough, the Yolo Bypass, or their tributaries, available water quality and pesticide use data indicate that these waterways may periodically carry significant diazinon and chlorpyrifos concentrations and loads into the Delta. The chlorpyrifos data for Cache Slough near its outlet occasionally exceed the proposed Water Quality Objective for chlorpyrifos, but the data set did not include any exceedances of the proposed objective for diazinon. Nevertheless, when the Yolo Bypass is flooded following January and February storms, it has the potential to carry significant diazinon loads from the Sacramento Valley into the Delta, since large quantities of Sacramento River water flow into the Yolo Bypass via Fremont Weir, and the diazinon concentrations in the Sacramento River near Fremont Weir[2] during winter storm flows range from below detections limits to 171 ng/L (Karkoski et al., 2003). Ulatis Creek is an agriculturally dominated upland drainage in this area, and the available data indicate that it frequently exceeds both the proposed diazinon and chlorpyrifos criteria. There are currently no available chlorpyrifos or diazinon data for Cache or Putah creeks.

[2] Reported concentration range is for the Sacramento River at Alamar (Veteran's Bridge), which is downstream of Fremont Weir

TableE5. Diazinon Data for the Northwest Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Yolo Bypass at I-80	6	30	52	53	0	0%
Calhoun Cut	6	0	5	10	0	0%
Haas Slough	1	49	49	49	0	0%
Lindsey Slough	27	0	9	21	0	0%
Ulatis Creek	73	9	100	380	5	7%
Barker Slough	11	10	50	55	0	0%
Prospect Slough	1	4	4	4	0	0%
Shag Slough	1	0	0	0	0	0%
Cache Slough at Hastings	22	0	18	46	0	0%
Cache Slough nr Outlet	49	9	37	96	0	0%

Table E6. Chlorpyrifos Data for the Northwest Data and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Yolo Bypass at I-80	6	0	0	0	0	0%
Calhoun Cut	6	0	0	0	0	0%
Haas Slough	1	0	0	0	0	0%
Lindsey Slough	27	0	1	9	0	0%
Ulatis Creek	73	8	91	137	28	38%
Barker Slough	11	0	0	0	0	0%
Prospect Slough	1	0	0	0	0	0%
Shag Slough	1	0	0	0	0	0%
Cache Slough at Hastings	22	0	5	12	0	0%
Cache Slough nr Outlet	49	0	4	36	1	2%

Table E7. Combined Criteria-Normalized Diazinon and Chlorpyrifos Data for the Northwest Data and Tributary Area

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Yolo Bypass at I-80	6	0.2	0.3	0.3	0	0%
Calhoun Cut	6	0.0	0.0	0.1	0	0%
Haas Slough	1	0.3	0.3	0.3	0	0%
Lindsey Slough	27	0.0	0.1	0.5	0	0%
Ulatis Creek	72	0.7	3.9	7.3	32	44%
Barker Slough	11	0.1	0.3	0.3	0	0%
Prospect Slough	1	0.0	0.0	0.0	0	0%
Shag Slough	1	0.0	0.0	0.0	0	0%
Cache Slough at Hastings	13	0.0	0.6	0.7	0	0%
Cache Slough nr Outlet	49	0.1	0.5	1.4	1	2%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Northern Delta Subarea

The Northern Delta subarea encompasses the northern part of the Legal Delta, reaching as far north as the Sacramento River at I Street bridge in the city of Sacramento (where the Sacramento River enters the Legal Delta) and as far south as the Sacramento River near Rio Vista. The western boundary of the Northern Delta subarea is defined in the north by the eastern levee of the Yolo Bypass, which is just west of the Sacramento River Deepwater Ship Channel. This boundary follows the west side of the Sacramento Deepwater Ship Channel to its intersection with Cache Slough, south of which the boundary is defined by the western extent of the upland watersheds that drain to the Sacramento River upstream of Rio Vista. The eastern boundary follows the eastern levee of the Sacramento River southward to the Delta Cross Channel. The southeastern boundary of the Northern Delta subarea extends just beyond the southeastern side of the Sacramento River upstream of the city of Rio Vista, containing the lands that drain to the Sacramento River from the southeast between the Delta Cross Channel and Rio Vista.

The surface water in the Northern Delta subarea is dominated by water from the Sacramento River, which is the largest tributary to the Delta. The Sacramento River enters the Delta at the city of Sacramento and flows through the Delta into Suisun Bay. During certain times of the year, some of the Sacramento River water is diverted through the Delta Cross Canal into the Mokelumne River where it flows into the Southern Delta for export. The surface water in the Northern Delta subarea also includes water from local agricultural island discharges, discharges from the Northwest Delta subarea via the Yolo Bypass/Cache Slough, flows from the Eastern Delta and Tributary subarea, and tidal mixing from the Western and Central Delta subareas. Figure E4 shows the Northern Delta subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

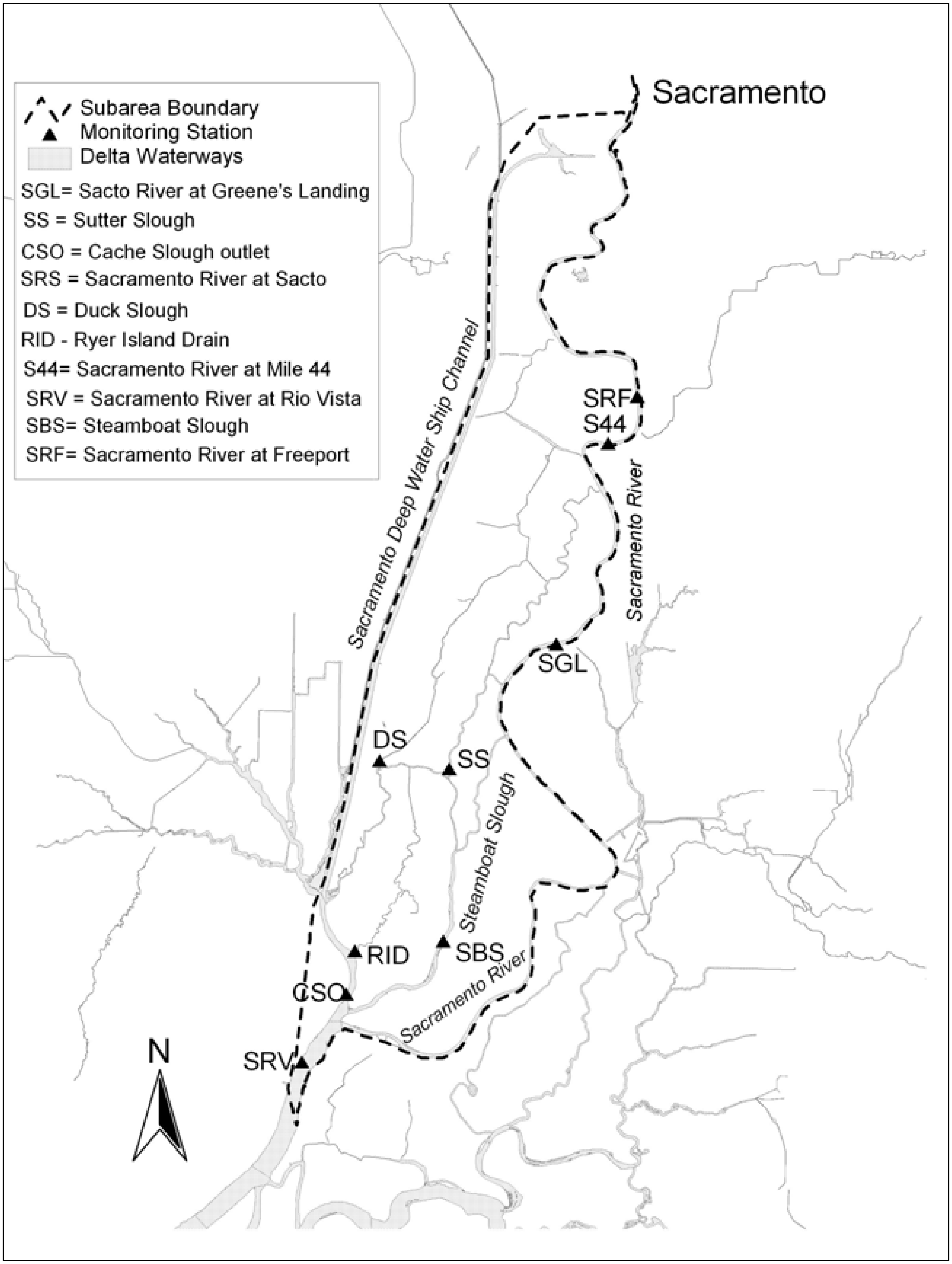

Figure E4. The Northern Delta Subarea

Diazinon and Chlorpyrifos Use in the Northern Delta Subarea

Agricultural diazinon use in the Northern Delta subarea averages approximately 4,400 pounds per year, based on use data from 1999-2003 with the main use being applications to pear orchards, which accounts for over 90% of the diazinon use in the Northern Delta subarea. Agricultural chlorpyrifos use in the Northern Delta subarea averages approximately 3,700 pounds per year, based on use data from 1999-2003 with the main uses being on alfalfa and apples.

Diazinon and Chlorpyrifos in the Northern Delta Subarea

Tables E8, E9 and E10 summarize diazinon and chlorpyrifos surface water concentration data for the Northern Delta subarea. The available data indicate the concentrations of diazinon occasionally exceed the proposed Water Quality Objectives in the Sacramento River within the Northern Delta subarea, and the chlorpyrifos concentrations occasionally exceed the proposed Water Quality Objectives in the Sacramento River and in Steamboat Slough, and more frequently in Duck Slough, an agriculturally dominated back slough.

Diazinon concentrations in the Sacramento River at the city of Sacramento range from below detectable levels to 307 ng/L, with the highest concentrations occurring following January and February storms. The timing of these elevated diazinon concentrations is coincident with the period of high diazinon use on nut and stonefruit trees during the dormant season, and also coincident with the period of heaviest rainfall in the Sacramento Valley and the Delta watershed. Elevated diazinon concentrations, combined with the high flows in the Sacramento River following winter storms, make January and February the time of year when the greatest diazinon loads enter the Delta from the Sacramento River. Daily diazinon loads in the Sacramento River during January and February of 1992-2001 range from approximately 200 grams per day to over 39,000 grams per day (Karkoski, et al., 2003). Diazinon concentrations in the Sacramento River within the delta have not been shown to exceed the proposed Water Quality Objectives outside of January and February.

Chlorpyrifos concentrations in the Sacramento River at the city of Sacramento are low compared with the San Joaquin River and other Delta tributaries, and exceedances of the proposed chlorpyrifos Water Quality Objectives are very infrequent in the Sacramento River at Sacramento. Since it is the downstream-most monitoring site, the Sacramento River at the city of Rio Vista makes a good integrator monitoring site to describe the concentrations of pesticides leaving the Northern Delta subarea. The occasional presence of significant concentrations of chlorpyrifos in the Sacramento River at the city of Rio Vista indicates significant loads of chlorpyrifos are discharged into the Sacramento River within the Northern Delta subarea, since there appears to be less chlorpyrifos present in the Sacramento River upstream at the cities of Sacramento and Freeport.

Table E8. Diazinon Data for the Northern Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Sac R at Sacramento	551	0	41	307	8	1%
Sac R at Freeport	189	0	12	140	0	0%
Sac R at Mile 44	70	0	0	70	0	0%
Sac R at Greene's Landing	6	24	167	280	1	17%
Sac R at Rio Vista	88	22	111	310	4	5%
Steamboat Slough	35	0	10	12	0	0%
Sutter Slough	2	0	0	0	0	0%
Duck Slough	47	0	27	58	0	0%
Ryer Island Drain	2	0	0	0	0	0%

Table E9. Chlorpyrifos Data for the Northern Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Sac R at Sacramento	520	0	0	30	1	0%
Sac R at Freeport	99	0	0	6	0	0%
Sac R at Mile 44	29	0	0	63	1	3%
Sac R at Greene's Landing	13	0	0	0	0	0%
Sac R at Rio Vista	89	0	0	36	2	2%
Steamboat Slough	35	0	0	33	1	3%
Sutter Slough	2	0	0	0	0	0%
Duck Slough	49	0	314	677	12	24%
Ryer Island Drain	2	0	0	0	0	0%

Table E10. Combined Criteria-Normalized Diazinon and Chlorpyrifos Data for the Northern Delta

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S Value	# of Samples S > 1	% of Samples S > 1
Sac R at Sacramento	521	0.0	0.3	1.9	9	2%
Sac R at Freeport	98	0.0	0.1	0.3	0	0%
Sac R at Mile 44	26	0.0	0.0	2.5	1	4%
Sac R at Greene's Landing	1	1.8	1.8	1.8	1	100%
Sac R at Rio Vista	88	0.1	0.8	1.9	6	7%
Steamboat Slough	35	0.0	0.1	1.3	1	3%
Sutter Slough	2	0.0	0.0	0.0	0	0%
Duck Slough	47	0.1	11.4	27.3	12	26%
Ryer Island Drain	2	0.0	0.0	0.0	0	0%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Eastern Delta and Tributary Subarea

The Eastern Delta and Tributary subarea contains the area in the Delta east of the Sacramento River downstream of the legal Delta boundary, and includes the South Mokelumne River, Little Potato Slough, Little Connection Slough, and the San Joaquin River/Stockton Deepwater Ship Channel downstream of the Legal Delta boundary, and extends east into the Sierra foothills as far as the mountainous regions southeast of Placerville and includes the communities of Cameron Park, El Dorado Hills, Plymouth, Sutter Creek, Amador City, Jackson, Ione, Sacramento (south of the American River), Galt, Lodi, Manteca, Escalon, Ripon and Stockton. This subarea includes upland reaches of the Mokelumne, Cosumnes and Calaveras rivers and numerous small creeks. The surface water within the Eastern Delta and Tributary subarea consists of waters from upstream reservoir releases, runoff from irrigation and rainfall within the Eastern Delta and Tributary subarea, and to a much lesser extent, water from tidal mixing from the adjacent Northern, Central and Southern Delta subareas.

The major tributaries entering the Delta from the East in this area include (from North to South) the Cosumnes River, the Mokelumne River, Bear Creek, Mosher Slough, Five Mile Slough, the Calaveras River, Mormon Slough, and French Camp Slough. These waterbodies receive runoff and drainage from agricultural and urban lands as they flow towards the Delta. Mosher Slough's, Five Mile Slough's, and Mormon Slough's watersheds include agricultural lands as well as urban lands in the Stockton area. While the flows from the Eastern Delta tributaries are smaller relative to the flows of the major rivers in the Delta (approximately 5% of total Delta inflows (DWR, 1995)), the diazinon and chlorpyrifos loads from these waterbodies can greatly affect the water quality in the Eastern Delta sloughs and river reaches into which they drain.

In the Sacramento area, Morrison Creek's watershed covers approximately 150 square miles, and includes agricultural and mostly urban land uses. Morrison Creek flows into the Sacramento River downstream of the city of Freeport in the Northern Delta subarea. The hydrology and presence of diazinon and chlorpyrifos in Morrison Creek and other urban streams in the Sacramento area are discussed in detail in the Total Maximum Daily Load Report for the Pesticides Diazinon and Chlorpyrifos in: Arcade Creek, Elder Creek, Elk Grove Creek, Morrison Creek, and Chicken and Strong Ranch Sloughs, Sacramento County, California (Spector et al., 2004).

Treated wastewater and urban runoff are discharged from the Sacramento County Regional Wastewater Treatment Plant to the Sacramento River just south of the city of Freeport. The maximum flow from this facility is 181-million gallons per day (mgd), which is approximately equal to 250 cfs. Treated wastewater (and, occasionally, untreated wastewater during very intense storm events) and urban runoff are also discharged from the City of Sacramento's Combined Wastewater Collection and Treatment System into the Sacramento River at various points near the city of Sacramento.

The Cosumnes River is relatively small and flows for 80 miles from its headwaters in the Sierra Nevada to its junction with the Mokelumne River in the Delta. The Cosumnes River is the only undammed river on the western slope of the Sierra Nevada. The Cosumnes River receives drainage from agricultural and urban lands south of the city of Sacramento, and receives, via its tributary Deer Creek, treated wastewater from the cities of Elk Grove, El Dorado Hills and Cameron Park.

The lower Mokelumne River flows westward from Camanche Reservoir in the Sierra Foothills into the Delta, where it splits into the North and South Mokelumne Rivers, then comes back together and flows into the San Joaquin River. The Mokelumne River is fed by drainage from agricultural lands and urban lands near the city of Lodi.

Bear Creek flows southwestward into the Delta at Pixley Slough, draining areas to the south and southeast of Lodi. Just south of Bear Creek's watershed, Mosher Creek flows southwestward into the Delta at Mosher Slough, draining agricultural areas to the east of Stockton and urban lands in northern Stockton.

The lower Calaveras River flows westward from New Hogan Lake into the Delta, where it flows into the San Joaquin River. Water from the Calaveras River is at times diverted southward into Mormon Slough, which branches off of the Calaveras River in the foothills and travels westward into the Delta, where it joins the San Joaquin River. The combined Mormon Slough/Calaveras River watershed contains a significant amount of both agricultural and urban land near the city of Stockton. South of Mormon Slough, Duck Creek flows westward into the Delta at Walker Slough. Littlejohns Creek and Lone Tree Creek flow westward and join, forming French Camp Slough.

Eastern Delta waterbodies include (from north to south) Snodgrass Slough, the Cosumnes River, the Mokelumne River, Beaver Slough, Hog Slough, Sycamore Slough, White Slough, Bishop Cut, Disappointment Slough, the Calaveras River, Mormon Slough, and French Camp Slough. Figure E5 shows the Eastern Delta and Tributary subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

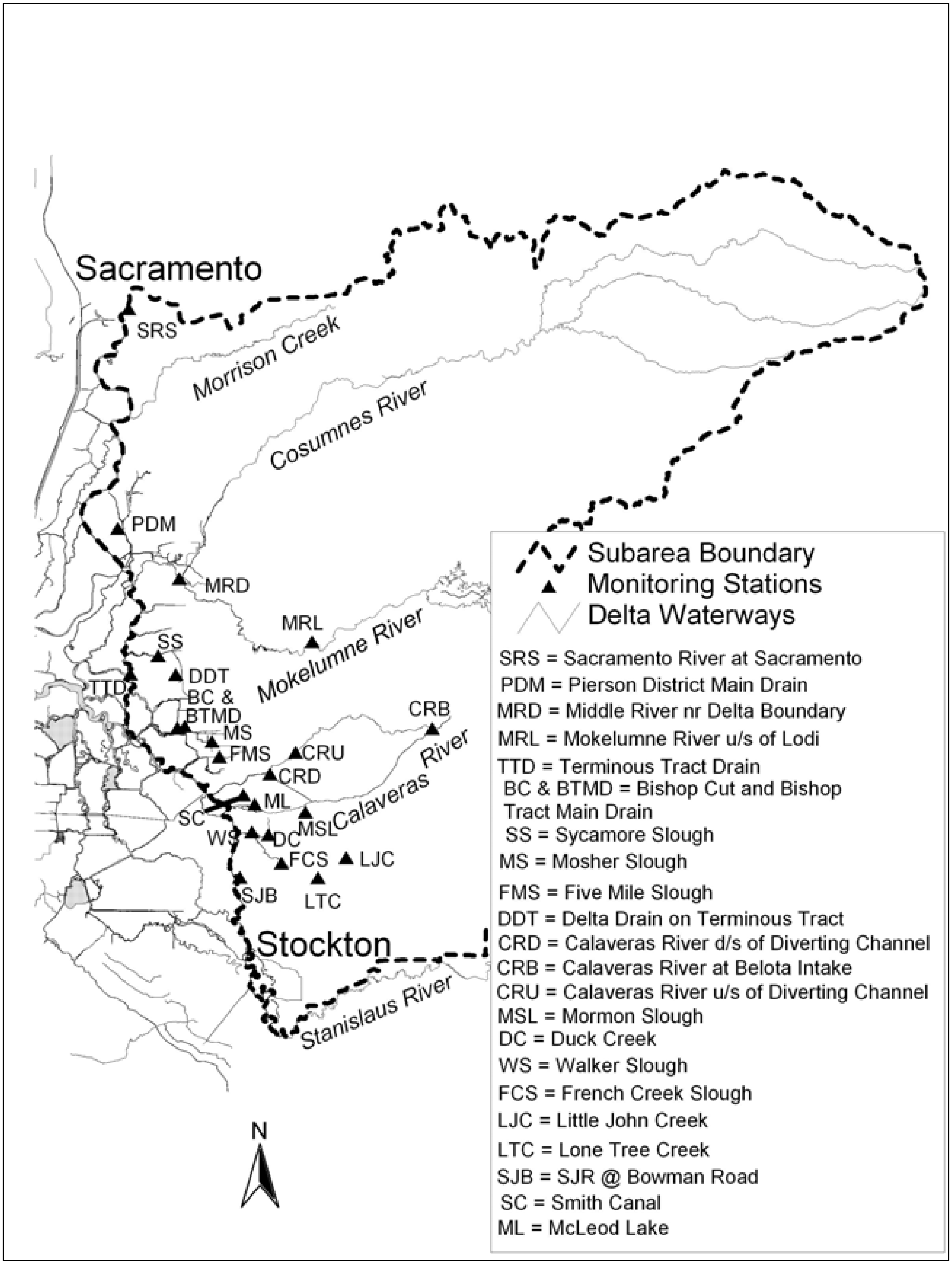

Figure E5. The Eastern Delta and Tributary Area

Diazinon and Chlorpyrifos Use in the Eastern Delta and Tributary Subarea

Agricultural diazinon use in the Eastern Delta and Tributary subarea averages approximately 18,000 pounds per year, based on use data from 1999-2003, with the main applications being to almond, cherry and apple orchards. Agricultural chlorpyrifos use in the Eastern Delta and Tributary Area averages approximately 49,000 pounds per year, based on use data from 1999-2003, with the main applications being to walnuts, alfalfa, almonds, corn and grapes. Apples and sugarbeets were also major chlorpyrifos uses in this subarea in the recent past. Urban use of both diazinon and chlorpyrifos was also likely high within this subarea in and around the cities of Stockton and Sacramento.

Diazinon and Chlorpyrifos in the Eastern Delta Waterways and Tributaries

Tables E11, E12 and E13 summarize available diazinon and chlorpyrifos data for the Eastern Delta and Tributary Area. The available data indicate that, where they enter the Delta, the Mokelumne and Calaveras Rivers occasionally contain chlorpyrifos and diazinon levels that exceed the proposed Water Quality Objectives. The smaller upland drainages flowing into the Delta from the east that receive urban and/or agricultural drainage also have occasional exceedances of the proposed Water Quality Objectives. The exceedances in these smaller upland drainages tend to be more frequent and with higher peak concentrations than in the Rivers in the Eastern Delta and Tributary Area. The smaller back sloughs within the Eastern Delta that receive urban and/or agricultural drainage also have measured exceedances of the proposed diazinon and chlorpyrifos Water Quality Objectives. The levels and frequency of exceedances in the small back sloughs appear to be greater than the exceedances in the rivers or the larger Delta sloughs where there is more dilution water available.

The upland drainages that receive urban runoff in the Sacramento area, such as Morrison, Elder and Elk Grove creeks, have been shown to have elevated diazinon and chlorpyrifos concentrations, especially following rainfall events (Karkoski et al., 2004). Similarly, back sloughs and small upland drainages receiving urban runoff in the Stockton Area have been shown to have elevated diazinon and chlorpyrifos concentrations, especially following rainfall events (Bailey, et al., 2000).

Further downstream, the San Joaquin River near the city of Stockton also has diazinon at levels that occasionally exceed the proposed Water Quality Objectives, but there have been no measured exceedances for chlorpyrifos. No chlorpyrifos or diazinon data are available for the Cosumnes River, Bear Creek, Snodgrass Slough, Beaver Slough, Hog Slough, Sycamore Slough, White Slough, or Disappointment Slough.

Table E11. Diazinon Concentrations for the Eastern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Mokelumne River near Delta Boundary	44	0	19	230	1	2%
Mokelumne River u/s of Lodi	4	0	0	0	0	0%
Sycamore Slough	1	0	0	0	0	0%
Delta Drain on Terminous Tract	4	0	11	16	0	0%
Bishop Cut	1	10	10	10	0	0%
Mosher Slough	77	130	547	1,400	31	40%
Five-Mile Slough	62	58	304	734	16	26%
Calaveras River at Belota Intake	2	0	0	0	0	0%
Calaveras River d/s Stockton Diverting Channel	43	43	308	1,700	10	23%
Smith Canal	1	129	129	129	0	0%
Mormon Slough	1	404	404	404	1	100%
Duck Creek	6	48	1,025	1,900	1	17%
McLeod Lake	4	0	14	20	0	0%
Pierson District Main Drain	1	0	0	0	0	0%
SJR at Bowman Rd	3	400	490	513	2	67%
SJR nr Stockton	50	80	258	797	15	30%
Littlejohns Creek	4	0	0	0	0	0%
Lone Tree Creek	9	120	1,390	2,790	4	44%
Walker Slough	6	0	85	170	1	17%
French Camp Slough	59	9	202	1,110	7	12%

Table E12. Chlorpyrifos Concentrations In the Eastern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Mokelumne River near Delta Boundary	42	0	0	43	2	5%
Mokelumne River u/s of Lodi	4	0	0	0	0	0%
Sycamore Slough	1	0	0	0	0	0%
Delta Drain on Terminous Tract	4	0	0	0	0	0%
Bishop Cut	1	10	10	10	0	0%
Mosher Slough	72	7	107	210	23	32%
Five-Mile Slough	61	0	49	104	11	18%
Calaveras River at Belota Intake	2	0	0	0	0	0%
Calaveras River ds Stockton Diverting Channel	43	0	53	110	6	14%
Calaveras River u/s SDC	2	117	130	133	2	100%
Smith Canal	1	46	46	46	1	100%
Duck Creek	6	22	105	120	3	50%
McLeod Lake	4	0	0	0	0	0%
Pierson District Main Drain	1	0	0	0	0	0%
SJR at Bowman Rd	3	0	8	10	0	0%
SJR at Buckley Cove	12	0	0	0	0	0%
SJR nr Stockton	50	0	0	16	0	0%
Littlejohns Creek	4	0	0	0	0	0%
Lone Tree Creek	9	0	3	14	0	0%
Walker Slough	5	0	30	35	1	20%
French Camp Slough	60	5	65	520	9	15%

Table E13. Combined Criteria-Normalized Diazinon and Chlorpyrifos Data for the Eastern Delta and Tributary Area

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Mokelumne River near Delta Boundary	42	0.0	0.1	2.1	2	5%
Mokelumne River u/s of Lodi	4	0.0	0.0	0.0	0	0%
Sycamore Slough	1	0.0	0.0	0.0	0	0%
Delta Drain on Terminous Tract	4	0.0	0.1	0.1	0	0%
Bishop Cut	1	0.5	0.5	0.5	0	0%
Mosher Slough	63	0.9	7.3	17.1	31	49%
Five-Mile Slough	57	0.3	3.5	6.4	17	30%
Calaveras River at Belota Intake	2	0.0	0.0	0.0	0	0%
Calaveras River ds Stockton Diverting Channel	43	0.6	2.7	14.6	15	35%
Smith Canal	1	2.6	2.6	2.6	1	100%
Duck Creek	6	1.2	10.6	16.7	3	50%
McLeod Lake	4	0.0	0.1	0.1	0	0%
Pierson District Main Drain	1	0.0	0.0	0.0	0	0%
SJR at Bowman Rd	3	2.5	3.4	3.6	2	67%
SJR nr Stockton	50	0.6	1.6	5.0	15	30%
Littlejohns Creek	4	0.0	0.0	0.0	0	0%
Lone Tree Creek	9	1.1	8.7	17.4	5	56%
Walker Slough	5	0.0	1.2	1.4	1	20%
French Camp Slough	58	0.5	3.4	21.0	17	29%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Southern Delta and Tributary Subarea

The Southern Delta and Tributary subarea encompasses the southern part of the Legal Delta and the lands that flow into the Southern Delta from the southwest. The Southern Delta and Tributary subarea's northern boundary is north of Clifton Court Forebay, Victoria Canal, and Trapper Slough extending as far east as the intersection of Old River and Burns Cutoff near Stockton. Its eastern boundary is east of the San Joaquin River, extending as far south as the San Joaquin River near Vernalis (the southern boundary of the Legal Delta). Its southwestern boundary extends from the western end of Clifton Court Forebay southeast to include all the tributary areas to the southwest of the Southern Delta.

The surface water in the Southern Delta and Tributary subarea is dominated by water from the San Joaquin River, the second largest Delta Tributary, but also contains local flows from irrigation and rainfall on Delta islands and upland areas, outflow from the Eastern Delta and Tributary subarea, and occasionally water from the Central Delta via tidal and export pumping-induced flows. The San Joaquin River enters the Delta from the south near the community of Vernalis. Unlike the Sacramento River, most of which flows through the Delta into San Francisco Bay during the entire year, the San Joaquin River's water flows through multiple channels, and is often diverted to the State Water Project (SWP) and Central Valley Project (CVP) pumps in the southern Delta near Clifton Court Forebay. Old River connects the San Joaquin River to Clifton Court Forebay. Paradise Cut and Tom Paine Slough connect the San Joaquin River to Old River. Grant Line Canal connects Old River to Clifton Court Forebay. There are a number of direct agricultural discharges where drainage is pumped from Delta islands into the San Joaquin River, Old River, Paradise Cut, Grant Line Canal and other Delta Waterways in the Southern Delta (DWR, 1995). The water in the area in and around Clifton Court Forebay is mostly Sacramento River water that is re-directed through the Central Delta towards the SWP and CVP export pumps. Figure E6 shows the Southern Delta and Tributary subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

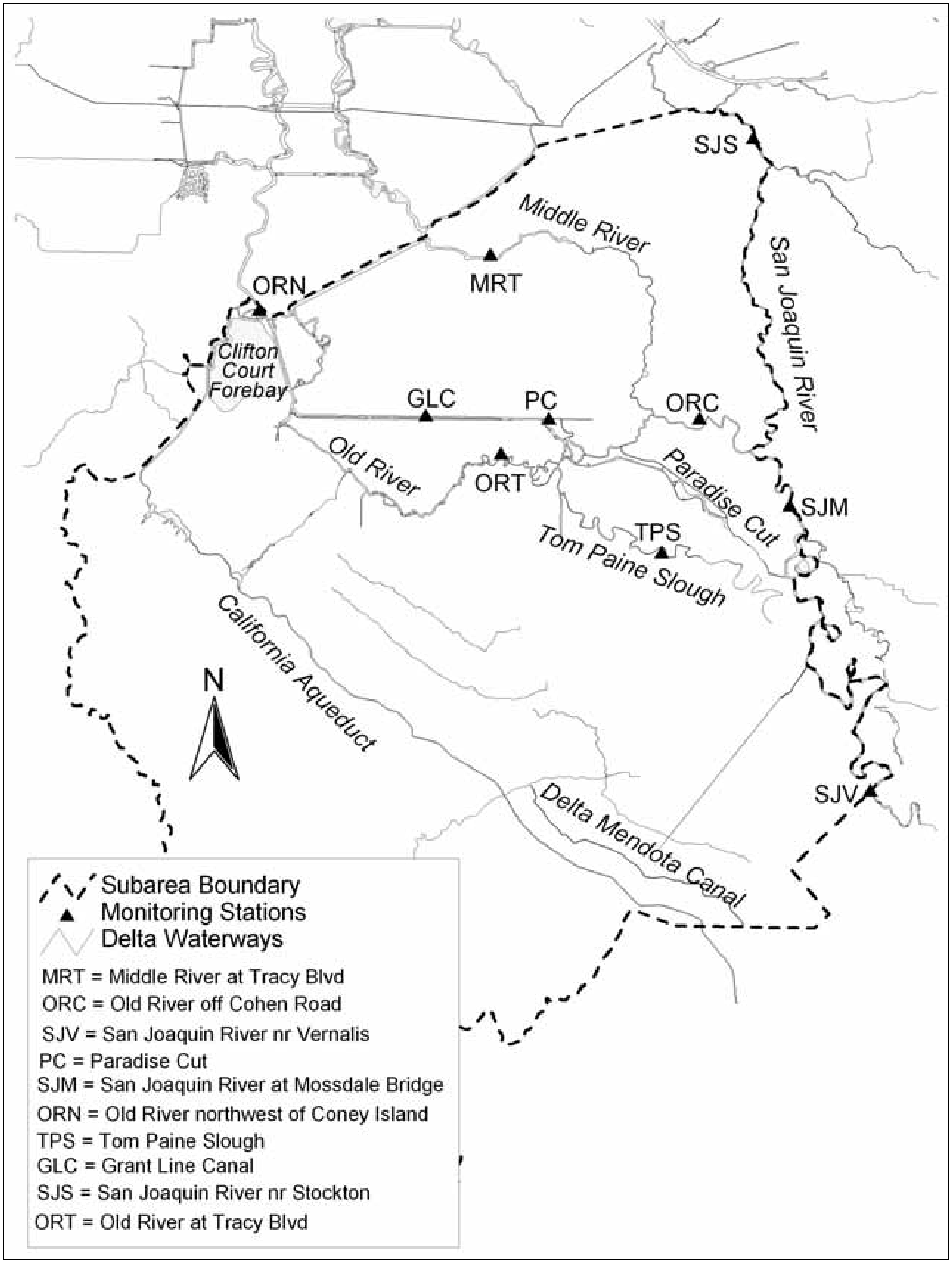

Figure E6. The Southern Delta and Tributary Subarea

Diazinon and Chlorpyrifos Use in the Southern Delta and Tributary Area

Agricultural diazinon use in the Southern Delta and Tributary Area averages approximately 2,000 pounds per year, based on use data from 1999-2003, with the only major use being applications to tomatoes. Agricultural chlorpyrifos use in the Southern Delta and Tributary Area averages approximately 12,000 pounds per year, based on use data from 1999-2003 with the major use being application to alfalfa, and a relatively minor use on walnut orchards.

Diazinon and Chlorpyrifos in the Southern Delta Waterways and Tributaries

Tables E14, E15 and E16 summarize available diazinon and chlorpyrifos data for the Southern Delta and Tributary Area. Over 1,000 samples have been collected from the San Joaquin River at where it flows into the Legal Delta near Vernalis. Many of those samples contained diazinon and chlorpyrifos concentrations that exceed the proposed Water Quality Objectives. Like diazinon concentrations in the Sacramento River at Sacramento, diazinon concentrations in the San Joaquin River at Vernalis are highest in January and February. Unlike the Sacramento River at Sacramento, however, diazinon concentrations in the San Joaquin River at Vernalis have exceeded the proposed Water Quality Objectives during the non-dormant season as well. Exceedances of the proposed diazinon Water Quality Objectives were observed in the Old River and in Grant Line Canal. Exceedances of the proposed chlorpyrifos Water Quality Objectives were also observed in the Old River, Grant Line Canal and Paradise Cut. Few data points are available for many of the other Delta Waterways in the Southern Delta.

Table E14. Diazinon Concentrations for the Southern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Middle River at Tracy Blvd	4	0	0	0	0	0%
Old River at Tracy Rd	33	0	16	38	0	0%
Old River off Cohen Road	2	229	331	357	1	50%
Old River Northwest of Coney Island	5	0	0	0	0	0%
Grant Line Canal	21	88	241	688	5	24%
Paradise Cut	36	0	25	125	0	0%
SJR nr Vernalis	1,237	4	93	1,216	72	6%
Tom Paine Slough	5	0	0	0	0	0%

Table E15. Chlorpyrifos Concentrations in the Southern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Middle River at Tracy Blvd	4	12	14	14	0	0%
Old River at Tracy Rd	33	0	8	37	1	3%
Old River off Cohen Road	2	0	0	0	0	0%
Old River northwest of Coney Island	5	0	0	0	0	0%
Grant Line Canal	21	0	15	76	1	5%
Paradise Cut	39	0	93	550	6	15%
SJR at Mossdale Bridge	12	0	0	0	0	0%
SJR nr Vernalis	1,185	0	9	110	19	2%
Tom Paine Slough	5	0	0	0	0	0%

Table E16. Combined Criteria-Normalized Diazinon and Chlorpyrifos Concentrations in the Southern Delta and Tributary Area

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Middle River at Tracy Blvd	4	0.5	0.6	0.6	0	0%
Old River at Tracy Rd	33	0.0	0.4	1.5	1	3%
Old River off Cohen Road	2	1.4	2.1	2.2	1	50%
Old River Northwest of Coney Island	5	0.0	0.0	0.0	0	0%
Grant Line Canal	21	0.8	1.6	4.3	6	29%
Paradise Cut	36	0.1	4.9	22.3	6	17%
SJR nr Vernalis	1089	0.1	1.0	9.1	105	10%
Tom Paine Slough	5	0.0	0.0	0.0	0	0%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Central Delta and Tributary Subarea

The Central Delta and Tributary Subarea contains the area bound by the other Delta subareas, and extends into the uplands southwest of the Legal Delta to contain all the lands draining into the Central Delta from the southwest. The sources of surface water in the Central Delta and Tributary subarea are a mix of water from the Northern Delta, Southern Delta, Eastern Delta, and the Western Delta subareas, as well as local runoff and discharges.

The waters from all of the Delta tributaries come together within the central Delta. The San Joaquin River flows through the center of the Delta. Georgiana Slough and the Delta Cross Channel connect the Sacramento River to the Mokelumne River. The North and Middle Forks of the Lower Mokelumne River flow into the San Joaquin River from the northwest, sometimes carrying Sacramento River water that is diverted into the Mokelumne River through the Delta Cross Channel. The Old and Middle rivers are connected to the San Joaquin River from the south. There are several additional interconnected sloughs, canals, and cuts within the Central Delta. Depending on the tides, the amount of flow in the rivers, and the amount of pumping at the SWP and CVP export pumps, the waters in the San Joaquin River, Old River and Middle River can change directions and flow towards the pumps instead of towards San Francisco Bay. There are dozens of direct agricultural discharges from Central Delta islands that are pumped over levees into the Delta Waterways. Figure E7 shows the Central Delta and Tributary subarea, including the monitoring sites from which pesticide concentration data were obtained for this report.

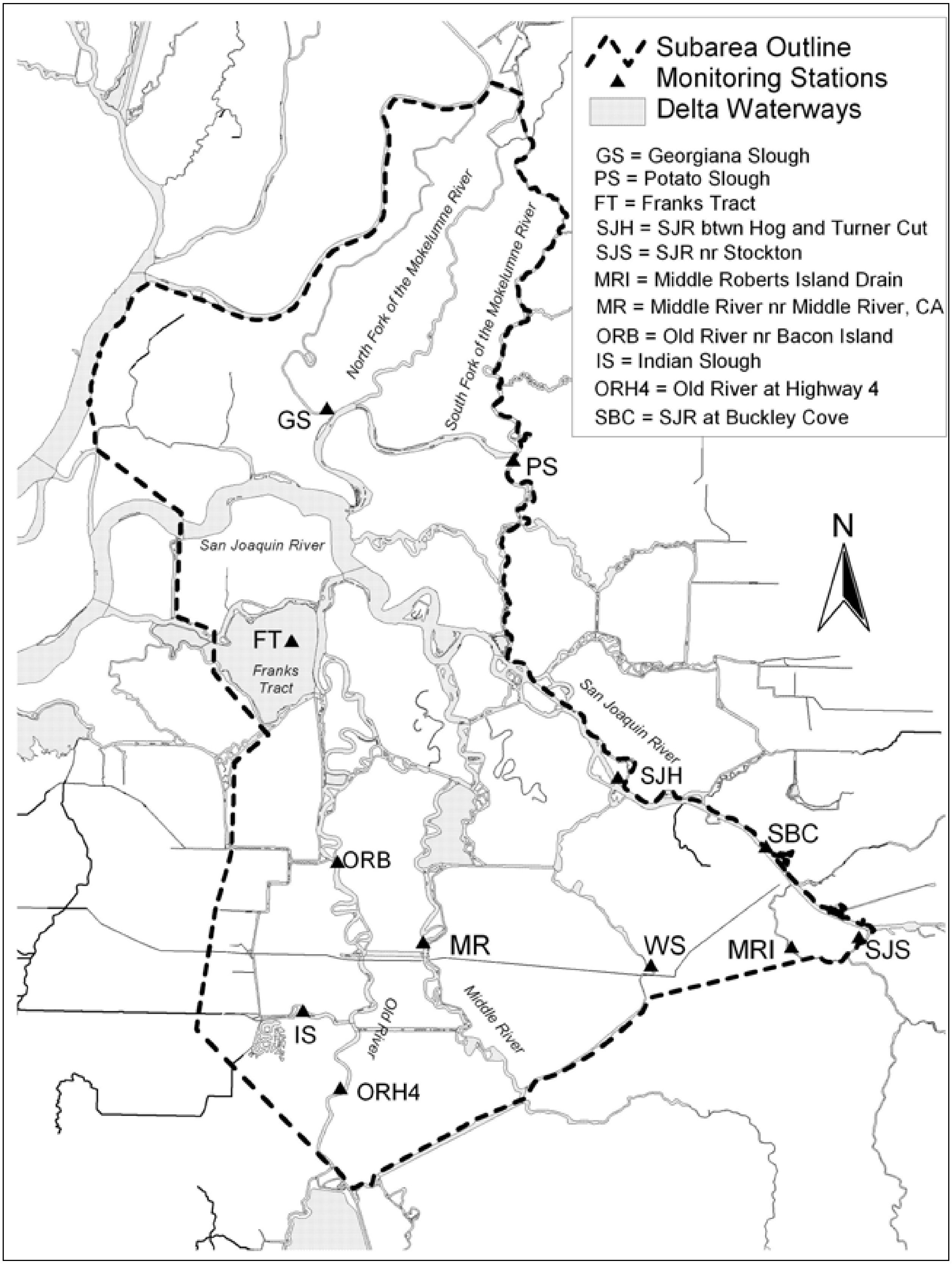

Figure E7. The Central Delta

Diazinon and Chlorpyrifos Use in Central Delta and Tributary Subarea

Agricultural diazinon use in the Central Delta and Tributary area is much less than all the other subareas, averaging approximately 350 pounds per year based on use data from 1999-2003, with the main uses being pears and tomatoes. Agricultural chlorpyrifos use in the Central Delta and Tributary Area averages approximately 3,500 pounds per year, based on use data from 1999-2003 with the main uses being asparagus and alfalfa.

Diazinon and Chlorpyrifos in Central Delta and Tributary Subarea

Tables E17, E18, and E19 summarize available diazinon and chlorpyrifos surface water concentration data for the Central Delta and Tributary subarea. With the exception of the San Joaquin River, no exceedances of the proposed Water Quality Objectives were measured within the Central Delta Waterways. This may be partially due to the large tidal flows from the west diluting pesticide concentrations in Central Delta. Unlike in other Central Valley rivers, following winter storms, well-defined diazinon pulses are not observed in the Old and Middle rivers in the Central Delta. This may be due to the mixing of multiple riverine sources of pesticides and the hydrologic complexity of the Central Delta. In January and February of 1993, the Old and Middle river's diazinon concentrations appeared to steadily increase, reaching maximum concentrations of 149 and 121 ng/L for the Old and Middle rivers, respectively (Kuivila and Foe, 1995). The water entering the Delta from Middle Roberts Island Drain (which is a considered to be a Delta island drain, and not a Delta Waterway) exceeded the proposed Water Quality Objectives for chlorpyrifos, but not diazinon. The data for the San Joaquin River near the city of Stockton indicate exceedances of the proposed Water Quality Objective for diazinon but there were no measured exceedances of the proposed Water Quality Objective for chlorpyrifos.

Table E17. Diazinon Concentrations in the Central Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Frank's Tract	4	0	0	0	0	0%
Georgiana Slough	6	0	0	0	0	0%
Indian Slough	7	17	26	30	0	0%
Middle River near Middle River	57	56	129	149	0	0%
Middle Roberts Island Drain	45	0	15	82	0	0%
Old River nr Bacon Island	35	38	93	121	0	0%
Potato Slough	4	0	0	0	0	0%
SJR btwn Hog and Turner Cut	5	0	0	0	0	0%
SJR nr Stockton	50	80	258	797	15	30%
Terminous Tract Drain	2	13	23	25	0	0%
Whiskey Slough	5	0	0	0	0	0%

Table E18. Chlorpyrifos Concentrations in the Central Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Frank's Tract	16	0	0	0	0	0%
Georgiana Slough	6	0	0	0	0	0%
Indian Slough	7	0	9	22	0	0%
Middle River near Middle River	57	0	0	4	0	0%
Middle Roberts Island Drain	45	9	56	360	11	24%
Old River nr Bacon Island	47	0	0	3	0	0%
Potato Slough	4	0	0	0	0	0%
SJR btwn Hog and Turner Cut	5	0	0	0	0	0%
SJR nr Stockton	50	0	0	16	0	0%
Terminous Tract Drain	2	6	11	12	0	0%
Whiskey Slough	5	0	0	0	0	0%

Table E19. Combined Criteria-Normalized Diazinon and Chlorpyrifos Concentrations in the Central Delta

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Georgiana Slough	6	0.0	0.0	0.0	0	0%
Indian Slough	7	0.1	0.5	1.0	0	0%
Middle River near Middle River	65	0.4	0.8	0.9	0	0%
Middle Roberts Island Drain	45	0.4	2.2	14.4	11	24%
Old River nr Bacon Island	35	0.2	0.6	0.8	0	0%
Potato Slough	4	0.0	0.0	0.0	0	0%
SJR btwn Hog and Turner Cut	5	0.0	0.0	0.0	0	0%
SJR nr Stockton	50	0.6	1.6	5.0	15	30%
Terminous Tract Drain	2	0.3	0.4	0.5	0	0%
Whiskey Slough	5	0.0	0.0	0.0	0	0%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Western Delta and Tributary Subarea

The Western Delta and Tributary subarea encompasses the westernmost side of the Delta within the Central Valley Region, and the upland areas that drain to this part of the Delta from the north and south. The sources of surface water in the Western Delta and Tributary subarea are a mix of water from tidal flows from San Francisco Bay in the San Francisco Bay Region, outward flows from the Northern, Central and Southern Delta subareas, and local irrigation and rainfall runoff. The voluminous tidal flows from San Francisco Bay provide significant dilution in the main channels of the Western Delta. The Western Delta and Tributary subarea's western boundary is the boundary between the Central Valley Region and the San Francisco Bay Region and its eastern boundary begins just west of Rio Vista and extends south past the western extents of Sevenmile Slough and Frank's Tract to the intersection of Rock Slough and Sand Mound Slough. Its northern and southern boundaries are defined by the Northwestern Delta and Tributary subarea and the Southern Delta and Tributary subarea.

The Sacramento and San Joaquin Rivers merge in the western Delta, where the Delta flows into Suisun Bay. The average tidal ebb or flood at Chipps Island is 170,000 cfs, while the average net Delta outflows are 32,000 and 6,000 cfs for winter and summer, respectively (DWR, 1995). The tidal flows from San Francisco Bay likely serve to dilute the concentrations of pesticides from the Central Valley. As with the other areas of the Delta, there are several direct agricultural discharges from western Delta islands that are pumped over levees into the Delta Waterways. Kellogg Creek, Marsh Creek, and a number of other small creeks flow into the Delta from the southwest. These creeks pass through agricultural and urban areas as they approach the Delta. Marsh Creek flows through the communities of Brentwood and Oakley and into the Delta at Big Break. Figure E8 shows the Western Delta and Tributary subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

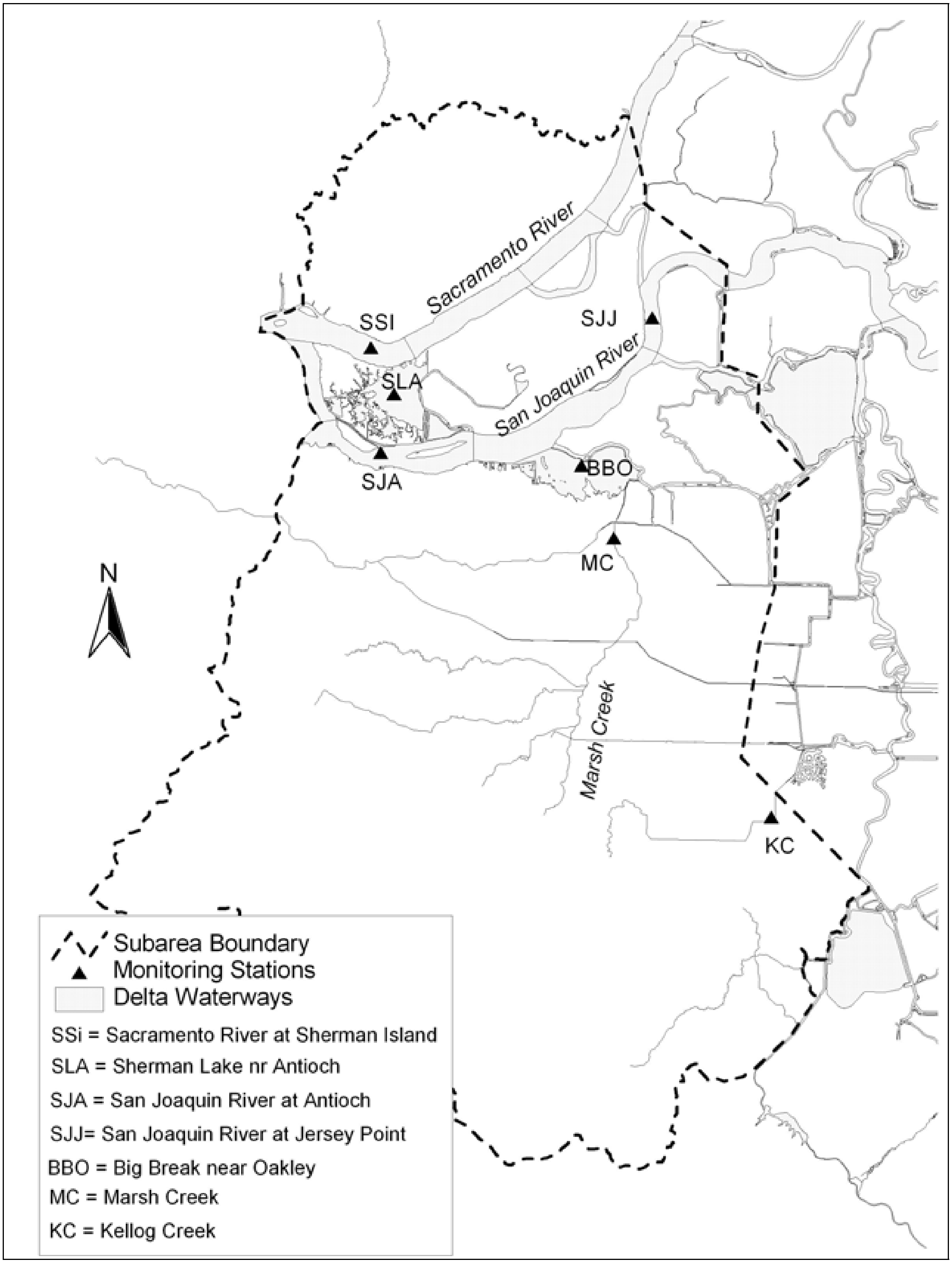

Figure E8. The Western Delta and Tributary Area.

Diazinon and Chlorpyrifos Use in the Western Delta and Tributary Area

Agricultural diazinon use in the Western Delta and Tributary Area averages approximately 1,600 pounds per year, based on use data from 1999-2003, with the main applications being to apple orchards. Agricultural chlorpyrifos use in the Western Delta and Tributary Area is much less than the use in any of the other Delta subareas, averaging approximately 500 pounds per year, based on use data from 1999-2003 with the main use being applications to corn fields.

Diazinon and Chlorpyrifos in Western Delta Waterways and Tributaries

Table E20 summarizes available diazinon and chlorpyrifos surface water concentration data in the Western Delta and Tributary subarea. As was the case in the Central Delta, exceedances of the proposed Water Quality Objectives were less common and of a lesser magnitude in the main Delta Waterways of the Western Delta when compared to the upstream areas such as the Northern, Eastern or Southern Delta subareas. This may be partially due to the large tidal flows from the west diluting pesticide concentrations in Western Delta.

Diazinon concentrations above the proposed Water Quality Objectives for diazinon have been observed in the Delta outflow near Chipps Island during a winter storm runoff event in February of 1993, when pulses of diazinon from the Sacramento River were traced across the Delta as far west as the delta outflow into Suisun Bay near Chipps Island (Kuivila and Foe, 1995). As with the rest of the Sacramento River, which is the main source of the Delta water as it flows into Suisun Bay, diazinon concentrations are highest in January and February in the Western Delta. Using data from samples collected infrequently (3 times per year from 1993-1998) at the Sacramento and San Joaquin rivers near their outlets, Davis and others (2000) estimated the annual diazinon and chlorpyrifos loads entering the San Francisco Bay from the Delta to be 1,100 kg/year and 28 kg/year, respectively. This was a rough estimate that did not characterize storm-event loads, so the actual annual loads are likely higher (Davis et al., 2000). Diazinon and chlorpyrifos concentrations above the proposed Water Quality Objectives were also observed in Kellogg and Marsh creeks.

Table E20. Diazinon and Chlorpyrifos Concentrations in the Western Delta and Tributary Subarea

Diazinon						
Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Max Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Kellogg Creek	1	0	0	0	0	0%
Marsh Creek	52	19	99	380	3	6%
SJR at Jersey Point	5	0	0	0	0	0%
SJR at Antioch	18	2	27	35	0	0%
Sac R nr Sherman Island	16	3	18	38	0	0%
Delta Outflow at Chipps Island	35	40	150	199	3	9%
Chlorpyrifos						
Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Max Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Sherman Lake near Antioch	12	0	0	0	0	0%
Kellogg Creek	1	180	180	180	1	100%
Marsh Creek	52	0	8	24	0	0%
Big Break near Oakley	11	0	0	0	0	0%
SJR at Jersey Point	5	0	0	0	0	0%
SJR at Antioch	29	0	0	1	0	0%
Sac R nr Sherman Island	28	0	0	1	0	0%
Delta Outflow at Chipps Island	35	0	0	0	0	0%
Combined Criteria-Normalized Diazinon and Chlorpyrifos						
Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Kellogg Creek	1	7.2	7.2	7.2	1	100%
Marsh Creek	52	0.1	1.0	2.7	4	8%
SJR at Jersey Point	5	0.0	0.0	0.0	0	0%
SJR at Antioch	16	0.0	0.2	0.2	0	0%
Sac R nr Sherman Island	15	0.0	0.1	0.2	0	0%
Delta Outflow at Chipps Island	35	0.25	0.94	1.24	3	9%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1.

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